ATTACHMENT - REMARKS

By this Amendment, independent claims 77 and 90 (and similarly withdrawn but re-joinable independent claim 93) have been amended to better define the invention. In addition, consistent amendments have been made in various dependent claims, while dependent claim 85 has been canceled. It is submitted that the present application is in condition for allowance for the following reasons.

In the *Claim Rejections - 35 USC § 102 and § 103* sections of the outstanding DETAILED ACTION, independent claims 77 and 90 together with associated dependent claims 78-85, 87-89 and 91-92 were all rejected as being anticipated by or obvious over Biemiller. However, for the following reasons, it is submitted that all of these claims are allowable over this reference.

Initially, it will be appreciated that the amendments to independent claims 77 and 90 incorporate the subject matters of dependent claims 78 (in part) and 85. The distinction now provided from Biemiller by these changes is that the balance wheel of the present invention includes a balance arm of a non-magnetic material having a thermal expansion coefficient (CTE) of less than 6×10^{-6} K^{-1}. Section 5 of the final Office Action acknowledges that this feature is not disclosed in Biemiller, but alleges that it would have been obvious at the time the invention was made to arrive at this feature. The reason given by the examiner is that this feature is allegedly "an optimum value of a result effective variable", which is discovered through the application of routine skill in the art. This argument does not take into account all of the factors relevant to the selection of material for the balance wheel arm in a thermally compensating system, as explained below.

210LT:20253:154890:1:ALEXANDRIA

In fact, for the arrangement disclosed in Biemiller, the optimum value for the balance arm CTE is not less than 6×10^{-6} K^{-1} because of the nature of the spring with which the balance arm is to be used. This may be illustrated by considering the timekeeping change formula [5] on page 8 of the present application:

$$U = \alpha_1 - \frac{3}{2}\alpha_2 - \frac{\delta E}{2E}$$

where U is the time change consequent on a rise in temperature of 1°C, α_1 is the balance wheel CTE, α_2 is the spring CTE, E is the Young's modulus of the spring, and δE is the change is Young's modulus consequent on the 1°C temperature rise. Thus, consideration of the thermal behavior of the spring is **essential** to arriving at an optimum value of α_1 for the balance wheel.

Biemiller suggests the use of a CuBe spring. The CTE of CuBe[1] is 17.6×10^{-6} K^{-1} and its thermoelastic properties are normal in the ambient range (i.e., E decreases with temperature[2], and the flat section implies that $\frac{\delta E}{2E}$ is negligible compared to the CTE value). The high CTE of the spring dominates the spring's contribution to the equation above through the $\frac{3}{2}\alpha_2$ term. Clearly an optimum value for α_1 to make U tend to zero is actually much <u>greater</u> than 6×10^{-6} K^{-1}.

Indeed, the above discussion shows that Biemiller is at best using an old state of the art which a person skilled in the art <u>at the time that the **present** invention was made</u> would immediately understand to fail if put into modern practice. The bimetallic arms

---

[1] See the table at the bottom of page 6 of the attached "Guide to Beryllium Copper" (multiplying the CTE value by 9/5 to equate to °C standard); any standard reference; or e.g., USP 5895533, figure 3.

[2] See the graph at the upper left side of page 38 of the attached "Guide".

38, 40 disclosed in Biemiller are alleged to serve as means for diminishing the moment of inertia of the balance to compensate for thermal changes in the Young's modulus of the spring. However, as one can see from the discussion above, the Young's modulus changes are dwarfed by the effect of thermal expansion of the spring. The bimetallic arms therefore appear to function <u>against</u> accurate timekeeping by acting to reduce the overall CTE of the Biemiller balance, i.e. reducing α_1 in the equation above.

Conversely, if Biemiller were to successfully compensate for the thermal properties of the spring, it would be clear to a skilled person when the present invention was made that the central section of the Biemiller balance wheel, i.e. the CuBe frame 20, the enclosed synthetic resin members 26, 34, the coil and the heavy metal studs 36, would need to exhibit a high enough overall CTE to overcome the reducing effect of the bimetallic arms. The skilled person is therefore directed <u>away</u> from reducing the CTE of a balance arm of a balance wheel in a non-magnetic system.

Therefore, for all of the foregoing reasons, it is submitted that amended independent claims 77 and 90 (and withdrawn 93) are neither disclosed nor made obvious by Biemiller so that these claims are now allowable. And for at least these same reasons, it is submitted that claims 78-84, 86-89, and 91-92 dependent from these independent claims are also allowable.

In the Allowable Subject Matter section, it was (again) indicated that dependent claim 86 contained allowable subject matter. This indication of allowable subject matter is appreciated. It is submitted that claim 86 is now allowable based on its dependence from now-allowable independent claim 77 from which it depends.

For all of the foregoing reasons, it is submitted that the present application is in

condition for allowance and such action is solicited.

Respectfully submitted,
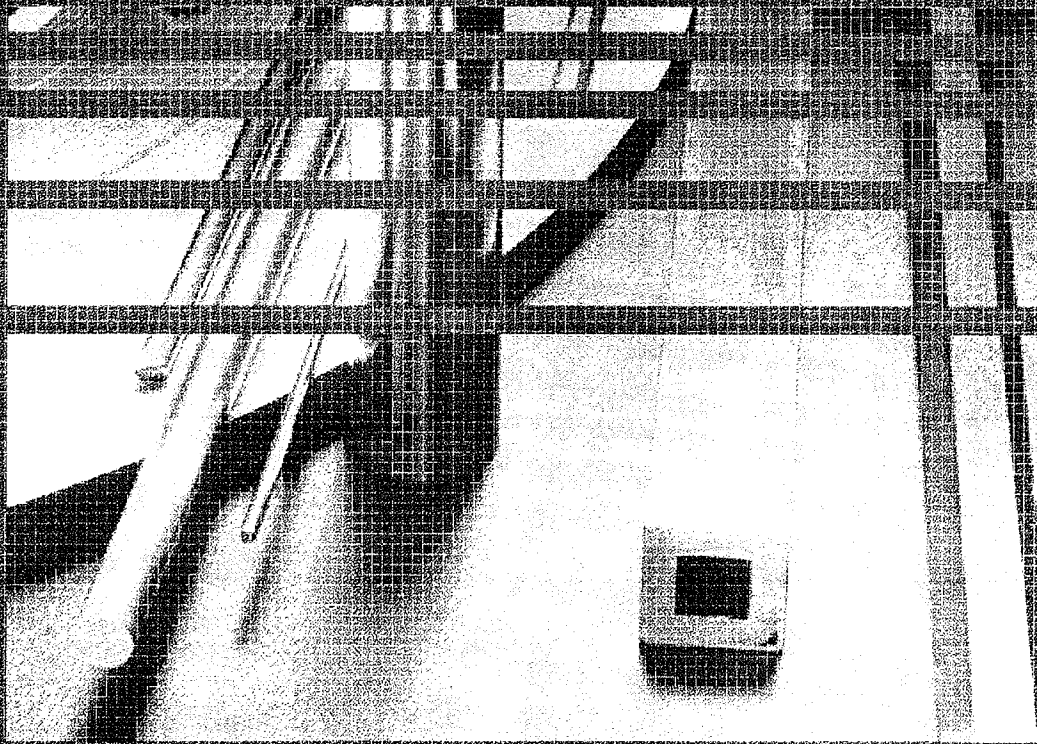
Date: November 18, 2009   /Douglas E. Jackson/
                    Signed By   Name: Douglas E. Jackson
            Attorney of Record   Registration No.: 28,518
STITES & HARBISON PLLC ◆ 1199 North Fairfax St. ◆ Suite 900 ◆ Alexandria, VA 22314
TEL: 703-739-4900 ◆ FAX: 703-739-9577 ◆ CUSTOMER NO. 881

210LT:20253:154890:1:ALEXANDRIA

Guide to Beryllium Copper

BRUSHWELLMAN
ENGINEERED MATERIALS

produced to the user's specification and are supplied in straight lengths.

Forgings, made from cast billet, are supplied in forms ranging from simple geometric configurations to near-net shapes according to user specifications.

Custom fabricated parts are supplied to customer drawings as finished or semi-finished parts. Such products are fabricated from basic product forms (rod, extrusions, plate, etc.) by processes such as ring rolling, forging, welding, and machining.

Physical Properties

Beryllium copper's physical and mechanical proper- ties differ considerably from those of other copper alloys because of the nature and action of the alloying elements, principally beryllium. Varying the beryllium content from about 0.15 to 2.0 weight percent produces a variety of alloys with differing physical properties. Typical values of some of these properties are presented in the table on this page.

Whether a high strength or a high conductivity alloy, some physical properties remain similar. For example, the elastic modulus of the high strength alloys is 19 million psi; for the high conductivity alloys, 20 million psi. Poisson's ratio is 0.3 for all compositions and product forms.

A physical property that differs significantly between alloy families is thermal conductivity, which ranges from about 60 Btu/(ft•hr•F) for high strength alloys to 140 Btu/(ft•hr•F) for the high conductivity grades. The thermal and electrical conductivities of beryllium copper promote its use in applications requiring heat dissipation and current carrying capacity. Electrical conductivity is listed with mechanical properties in the Product Guide section of this book.

The thermal expansion coefficient of beryllium copper is independent of alloy content over the temperature range in which these alloys are used. The thermal expansion of beryllium copper closely matches that of steels including the stainless grades. This insures that beryllium copper and steel are compatible in the same assembly.

Specific heat of beryllium copper rises with temperature. For Alloys 25, M25 and 165, it is 0.086 Btu/(lb•F) at room temperature, and 0.097 Btu/(lb•F) at 200 F. For Alloys 3, 10 and 174 it rises from 0.080 to 0.091 Btu/(lb•F) over the same temperature range.

Magnetic permeability is very close to unity, meaning that the alloys are nearly perfectly trans- parent to slowly varying magnetic fields.

Beryllium copper high strength alloys are less dense than conventional specialty coppers, often providing more pieces per pound of input material. Beryllium copper also has an elastic modulus 10 to 20 percent higher than other specialty copper alloys. Strength, resilience, and elastic properties make beryllium copper the alloy of choice.

Typical Physical Properties

Brush Alloy	Density lb/cu in.	Elastic Modulus 10⁶ psi	Thermal Expansion Coefficient in./in./°F, 70°F to 400°F	Thermal Conductivity Btu/(ft•hr•°F)	Melting Temp. °F
25 M25	0.302	19	9.7×10^{-6}	60	1600-1800
165	0.304	19	9.7×10^{-6}	60	1600-1800
3	0.319	20	9.8×10^{-6}	140	1900-1980
10	0.319	20	9.8×10^{-6}	115	1850-1930
174	0.318	20	9.8×10^{-6}	135	1880-1960

Note: Tabulated properties apply to age hardened products.
Before age hardening the density is: 0.298 lb/cu.in. for Alloys 25, M25 and 165; 0.316 lb/cu.in. for Alloys 3 and 10.
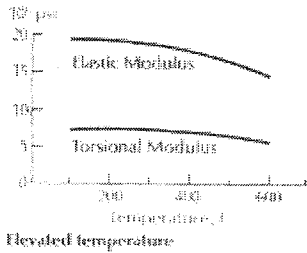
Elevated Temperature Strength - Beryllium copper Alloy 25 demonstrates good stability of tensile properties from cryogenic temperatures through 500 F despite long exposure. When tested at elevated temperature at conventional strain rates, tensile properties retain essentially room temperature values through 500 F.

The high conductivity alloys retain strength through about 600 F. The hardness of these alloys leads to their use in welding electrodes and mold components for plastic injection.
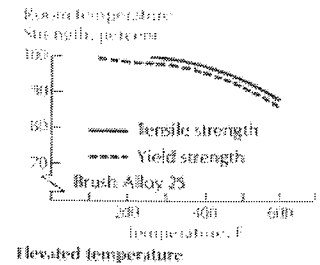
Reflectivity - Beryllium copper polishes readily to an optical mirror surface. Because of its color, this surface reflects light efficiently, especially in the infrared spectrum. Reflectivity, machinability and dimensional stability lead to its use in mirrors, particularly where centrifugal or other stresses are present.

Dimensional Stability - Besides increasing hardness and strength, age hardening can relieve stress in beryllium copper. This results in high dimensional stability during machining or stamping. A conventional stress relief that does not alter strength, and various stabilizing thermal treatments are used.
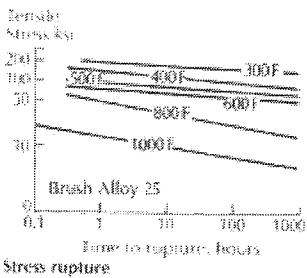
Special Surface Treatments - Surface modification of beryllium copper creates several unique possibilities. An oxide formed at high temperature greatly increases secondary electron emission. Various technique have been used for local hardening. Laser and electron beam techniques have produced various surface states, ranging from localized solution annealing to glazing. Coatings have been applied for increased emissivity, hardening or appearance.

Appearance - The golden luster of high strength alloys and the coral tinted gold of the high conductivity alloys give beryllium copper an attractive appearance. These alloys are polished and waxed or lacquered for application as decorative components.